TALON™ Products

For polyhistidine-tagged protein purification

Product	Application
TALON™ Metal Affinity Resin Resin ready for loading in columns for small or medium-scale purification of His-tagged proteins. Purify > 5 mg protein using 1 ml of resin.	For purification of most cytosolic and secreted His-tagged proteins by small-scale or batch/gravity flow, under native or denaturing conditions
TALON™ Superflow Resin Specially designed for quick and effective purification of His-tagged proteins at high flowrates and medium-pressure (up to 150 psi).	For FPLC, medium-pressure chromatography, or scale-up for production applications
TALON™ CellThru Novel IMAC resin designed for quick purification of His-tagged proteins by direct capture.	For small-scale single-use applications such as verifying positive transformants for His-tagged protein expression levels, or trial-level purification protocols.
TALONspin™ Columns Ready-made spin columns containing TALON-NX™ resin for the simultaneous purification of several His-tagged proteins in parallel in only 30 minutes.	For small-scale single-use applications such as verifying positive transformants for His-tagged protein expression levels, or trial-level purification protocols.
TALON™ Purification Kit Convenient kit containing TALON resin, columns, and all the buffers necessary to extract, wash, and elute His-tagged proteins. This kit provides the ideal place to start when using TALON in your applications.	
TALON™ Disposable Columns Two different types of disposable columns—one for use with TALON Resin for regular His-tagged protein purification and one for use with CellThru Resin for purification from crude lysates.	
TALON™ Buffer Kit Supplemental kit containing concentrated forms of optimized buffers for extracting, washing, and eluting proteins.	

TALON™ Metal Affinity Resin

TALON Resins are durable, cobalt-based IMAC resins designed to purify recombinant poly-histidine-tagged proteins (Bush *et al.*, 1991). These resins are compatible with many commonly used reagents, and allow protein purification under native and denaturing conditions. They can be used with all prokaryotic and eukaryotic expression systems in a variety of formats, including small- (mini-) scale batch screening, large-scale batch preparations, and methods using gravity-flow columns and spin columns.

Introduction

Proteins have evolved very complex structures in order to perform a diverse array of functions. As a result, their physicochemical properties vary greatly, posing difficulties when developing versatile purification protocols. A host of purification methods have been developed that capitalize on the general physical properties of proteins. One of the quickest and easiest ways to purifying a protein is to use affinity chromatography since it is generally a more selective method of purification, which lets the protein of interest can be purified in one or two steps. However, many proteins have not been characterized sufficiently, or do not have any known strong binding properties that can be utilized for purification. One way to circumvent this problem is to incorporate a purification tag into the primary amino acid sequence of a target protein, thus constructing a recombinant protein with a binding site that allows purification under well-defined, generic conditions.

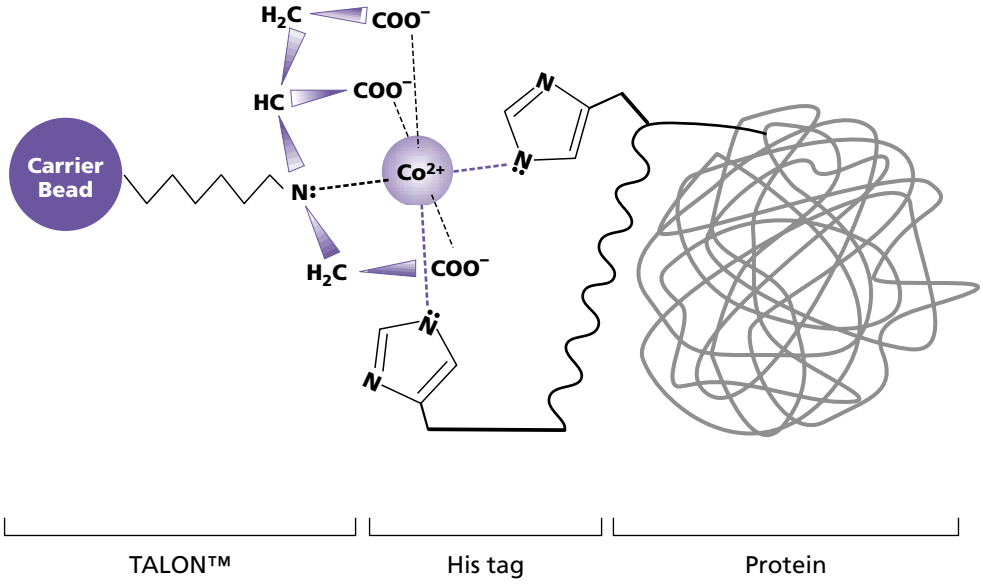

Figure 2. Molecular mechanism of histidine binding to TALON™ Resin.

IMAC technology

TALON Resin is an immobilized metal affinity chromatography (IMAC) resin based on our innovative, patented technology. IMAC was introduced in 1975 as a group-specific affinity technique for separating proteins (Porath *et al.*, 1975). This principle is based on the reversible interaction between various amino acid side chains and immobilized metal ions. Depending on the immobilized metal ion, different side chains can be involved in the adsorption process. Most notably, histidine, cysteine, and tryptophan side chains have been implicated in protein binding to immobilized transition metal ions and zinc (Porath, 1985; Sulkowski, 1985; Hemdan & Porath, 1985a; Hemdan & Porath, 1985b; Zhao *et al.*, 1991).

His-tag purification

Histidines exhibit highly selective binding to certain metals and have great utility in IMAC. Under conditions of physiological pH, histidine binds by sharing electron density of the imidazole nitrogen with the electron-deficient orbitals of transition metals. Although only three histidines may bind transition metals under certain conditions, six histidines reliably bind transition metals in the presence of strong denaturants such as guanidinium (Hochuli *et al.*, 1987). Such protein tags are commonly referred to as 6xHis tags. We have developed several other His-tag purification systems, including 6xHN and HAT. These tags possess characteristics favorable for binding to IMAC resins and improve protein solubility and yield (see page 22).

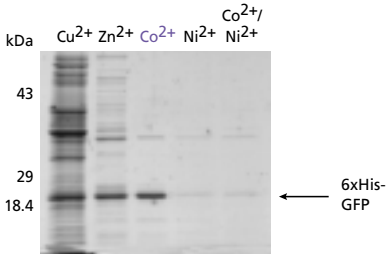

Figure 3. The cobalt ion has higher affinity and specificity for His-tagged proteins. The indicated metals were immobilized onto sepharose CL-6B (Pharmacia) using TALON's unique tetradentate chelator. 20 µl of eluate from the indicated resin was electrophoresed on a 12% polyacryl-amide gel and stained with Coomassie blue.

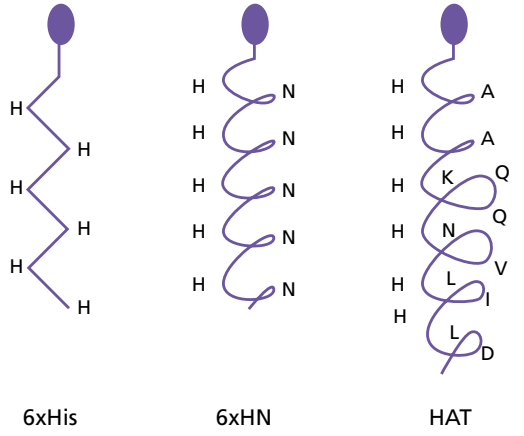

Figure 4. Hypothetical structures of commonly used histidine-affinity tags.

Unique Properties of TALON™ Resin

Reactive core contains cobalt

TALON has a remarkable affinity and specificity for His-tagged proteins (Figures 3, 7, 9, 10, & 11). The TALON reactive core, which contains cobalt, has strict requirements for the spatial positioning of histidines. Only adjacent histidines or specially positioned, neighboring histidines are able to bind cobalt in this reactive core. In nickel-based resins (i.e. Ni-NTA Resin), these spatial requirements are less strict. Therefore, nickel-based resins are also able to bind histidines located in places other than the protein's His-tag (Figure 3).

Uniform matrix

Cobalt-based resins have a more uniform structure than nickel-based resins. All reactive sites in TALON resin look like three-dimensional pockets, similar to the one drawn in Figure 2. In these pockets, cobalt is bound to three carboxyl groups and one nitrogen atom, and is able to bind to two other ligands, i.e. two histidines. In this configuration, cobalt is bound very tightly and does not leak out of the resin. Nickel-based resins are less homogeneous in structure because nickel ions can form two different coordination structures. One of them is a three-dimensional pocket, similar to TALON. The other structure is planar (flat). In this distorted, planar structure nickel is bound to only two carboxyl groups and one nitrogen atom. Since this binding is not very strong, planar reactive cores are not able to hold nickel ions very tightly. This leads to leaching of the nickel ion from the resin.

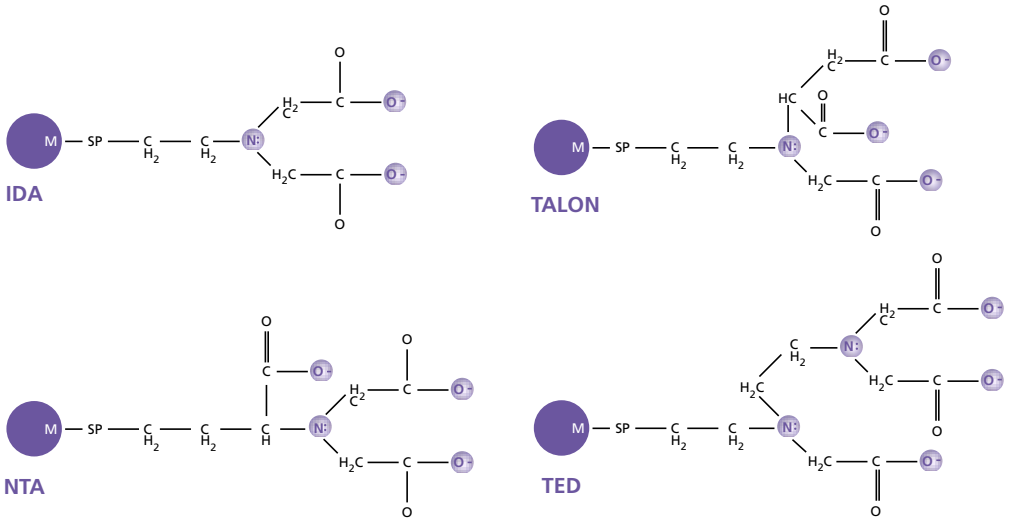

Figure 5. Chemical structures of chelating ligands used in IMAC. Binding groups are colored purple. SP = spacer. M = matrix.

Unique Properties of TALON™ Resin...*cont.*

Comparison with Ni-NTA resin

TALON exhibits subtle yet important differences in character when compared with nickel IMAC resins. For example, nickel-based IMAC resins often exhibit an undesirable tendency to bind unwanted host proteins containing exposed histidine residues (Kasher *et al.*, 1993). In contrast, TALON binds polyhistidine-tagged proteins with enhanced selectivity over nickel-based resins, and it also exhibits a significantly reduced affinity for host proteins (see page 6; Sulkowski, 1989). This characteristic offers two practical advantages. First, virtually no background proteins are bound to TALON when the sample is applied; consequently, cumbersome washing procedures are not generally required before protein elution. Second, polyhistidine-tagged proteins elute from TALON under slightly less stringent conditions—a slightly higher pH or lower imidazole concentration—than with nickel IMAC resins. Elution occurs when the imidazole nitrogen (pKa of 5.97) is protonated, generating a positively charged ammonium ion, which is repelled by the positively charged metal atom. Alternatively, simply adding imidazole to the elution buffer can competitively elute the bound polyhistidine-tagged protein because imidazole is structurally identical to the histidine side chain and therefore out-competes histidines for resin binding.

Why metal leaching is detrimental to protein purification

During protein purification, metal separates from the reactive core of the purification resin and flows down the column. This is called metal leaching. When metal leaching occurs, it reduces the number of reactive sites available for protein binding on the column, therefore reducing the amount of purified protein obtained.

All metals will leach out of a resin, but nickel leaches more readily than cobalt. Nickel can also precipitate proteins by forming salt bridges, can be toxic to cells and tissues, and can damage purified protein because of its nucleophilic properties. For these reasons, TALON Resin employs cobalt in its reactive core rather than nickel.

Table I: Comparison of TALON™ Metal Affinity Resin vs. Ni-NTA Resin

	TALON™ Resin	Ni-NTA Resin
Metal	Cobalt	Nickel
Metal Ion Complex	Strong	Weak, metal leakage results no metal leakage in lower yields of His-tagged protein and contamination by nonspecific proteins
Sensitivity to β-mercapto-ethanol	Low to negligible sensitivity when concentration < 30 mM	High, resulting in low yields of His-tagged protein
Performance under denaturing conditions	++	+
Performance under nondenaturing conditions	+	+
Reusability	++	+
Nonspecific protein binding	None	Significant

Protein Purification with TALON™

Denaturing vs. native conditions

Purification conditions

Deciding whether to use native or denaturing purification conditions depends on protein location, solubility, accessibility of the histidine tag, downstream applications, and preservation of biological activity. TALON Resin retains its protein binding specificity and yield in a variety of purification conditions. It is stable in both denaturing and native (nondenaturing) conditions.

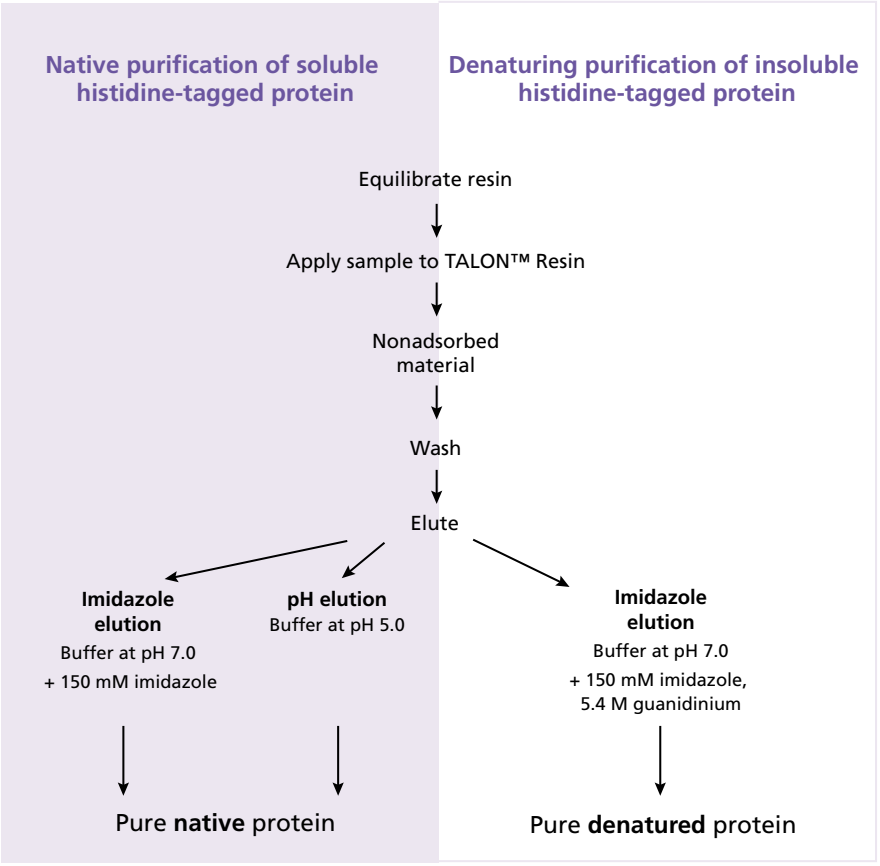

Figure 6. Native vs. denaturing purification procedures.

Why use denaturing conditions?

Denaturants, such as 6 M guanidinium, enhance protein solubility. Because proteins that are overexpressed in prokaryotic systems sometimes form insoluble aggregates called inclusion bodies, you may need to purify proteins under denaturing conditions. Strong denaturants such as 6 M guanidinium or 8 M urea completely solubilize inclusion bodies and 6xHis-tagged proteins. Under denaturing conditions, the 6xHis tag on a protein will be fully exposed so that biding to the matrix will improve, and the potential for nonspecific binding will be greatly reduced.

6xHis-tagged proteins purified under denaturing conditions can be used directly in subsequent applications, or may need to be renatured and refolded. Protein renaturation and refolding can be performed prior to elution from the column (Holzinger *et al.*, 1996) or in solution (Wingfield *et al.*, 1995). However, yields of recombinant proteins will be lower than under native conditions. This is because urea and guanidinium molecules compete with histidines for binding to metal.

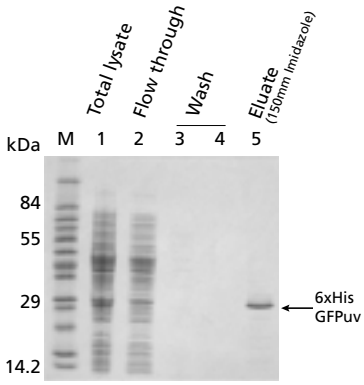

Figure 7. Purification of 6xHis-GFPuv under denaturing conditions. The fusion protein was purified in 8-M urea using TALON resin. M=molecular weight markers.

Protein Solubility

Protein solubility is largely dependent on two factors: the hydrophobicity of the amino acids in the polypeptide backbone, and the ability of the protein to fold correctly. Researchers can use a number of standard methods developed to influence protein solubility. At the level of protein expression, protein solubility can be changed by changing the level of expression. In *E. coli* Recombinant proteins that are overexpressed are frequently found to form protein aggregates called inclusion bodies. Such structures are believed to be masses of the expressed protein that have not folded correctly. Depending on your application, inclusion body formation can frequently be overcome by either reducing the level of expression. Alternatively, switching from 6xHis tag to HAT tag may help to increase protein solubility (see page 22 for details). Sometimes switching to a eukaryotic expression system helps the solubility of expressed protein because eukaryotes have the ability to add post-translational modifications or utilize chaperonin-assisted protein folding. At the level of protein purification, solubility can be increased by changing the temperature or salt concentration, or using reducing agents and denaturants in the method.

Why use native conditions?

Purifying a protein under native conditions is the most efficient method of retaining its biological activity. In order to use native conditions the protein must be soluble. Purification of proteins under native conditions is advantageous not only because you avoid the renaturation step at the end of the purification, but also because native purification will usually copurify enzyme subunits, cofactors, and associated proteins present in the cells (Le Grice, *et al.*, 1990; Flachmann & Khulbrandt, 1996). When renaturing protein after a denaturing purification, it is uncommon to regain more than 2–5% of the activity.

One disadvantage of using native conditions is that unrelated, nontagged proteins are more likely to be nonspecifically bound to the TALON Resin than with denaturing conditions. However, the nonspecific binding can be reduced by including a low concentration of imidazole (5–20 mM) in the wash buffer.

Sometimes the 6xHis tag is concealed by the tertiary structure of the soluble protein, so the protein must be denatured before it can be purified. If purification can only be performed under denaturing conditions, and this does not suit the downstream applications, an inaccessible tag can be moved to the other terminus of the protein. Alternatively, a larger tag like HAT or 6xHN can be used (see page 22).

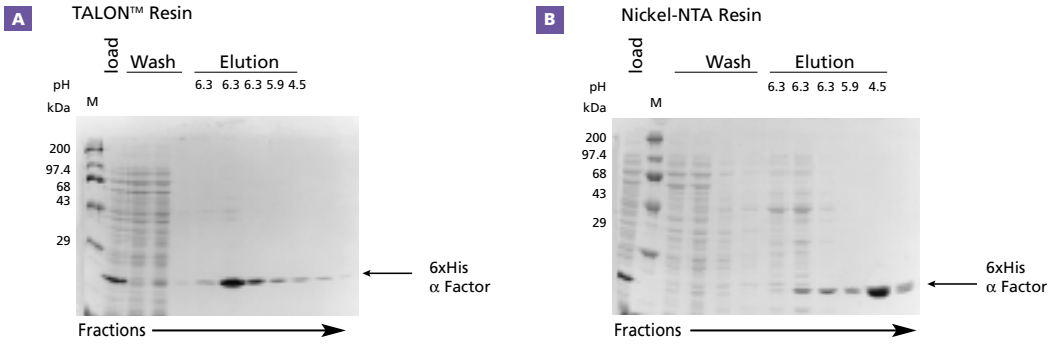

Figure 8. Purification of 6xHis proteins under native conditions compared to purification using Ni-NTA. In comparison with Ni-NTA resin, TALON is more specific for His-tagged proteins. His-tagged proteins can be eluted from TALON at more neutral conditions (pH = 6.3) than from Ni-NTA resins (pH = 4.5). 6xHis-tagged prepro-α-factor was expressed in *E. coli*, lysed and loaded onto each gravity flow column and eluted by a step-wise pH gradient. Purified fractions were analyzed by SDS-PAGE. M=molecular weight markers.

TALON resin preserves the native activity of purified proteins. Figure 9 shows that biological activity of green fluorescent protein (GFPuv) is preserved when purified using TALON Superflow Resin.

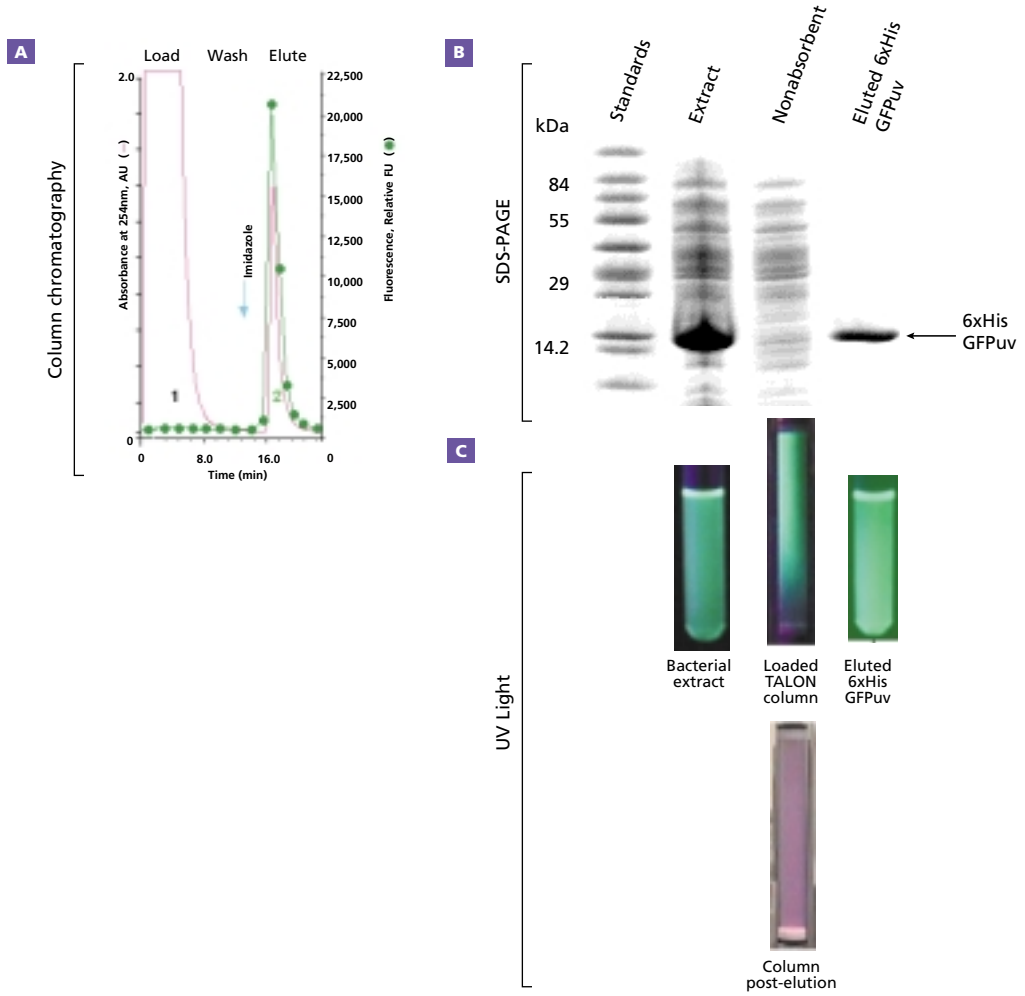

Figure 9. Native purification with TALON™ preserves biological activity of proteins. Fresh cells (0.5 g) expressing 6xHis-GFPuv were extracted in 5 ml of 50 mM sodium phosphate; 0.3 M NaCl, pH 7.0 **Panel A.** Elution profile of GFP which was loaded, washed with the same buffer, and eluted with a step gradient of imidazole (150 mM). **Panel B.** Fractions were analyzed by SDS-PAGE. **Panel C.** Active, intact GFP protein visualized under UV light.

Purification with β-Mercaptoethanol

Why use β-mercaptoethanol in protein purification?

Some intracellular proteins contain reduced sulfhydryl (-SH) groups that are important for the biological activity and structure of the protein. Adding β-mercaptoethanol helps to preserve those -SH groups during purification.

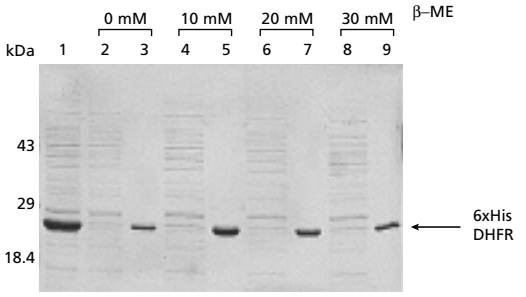

Figure 10. Native Purification of 6xHis protein in the presence of β-mercaptoethanol. N-terminal 6xHis-tagged mouse DHFR (19.5 kDa) was expressed in *E. coli*. 2 ml of lysate was purified using gravity flow on TALON resin in increasing concentrations of β-mercaptoethanol. Even lanes: 20 µl of non-adsorbed material. Odd lanes: 5 µl of eluate.

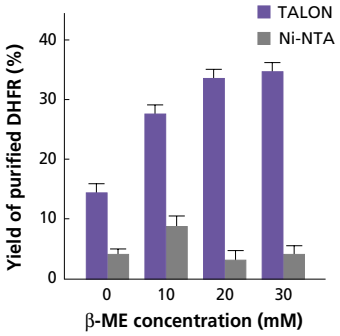

Figure 11. Yields of purification in the presence of β-mercaptoethanol compared to Ni-NTA resin. N-terminal 6xHis DHFR was expressed and purified under native conditions. Protein concentrations were determined by Bradford assay. Yields are expressed as a percentage of total protein in the cell lysate.

Formats of TALON™ Resin

Physicochemical properties

Table II: Physicochemical properties of TALON™ Resins

Features	TALON™ Superflow TALON™ Resin	TALON™ Resin	TALONspin™ CellThru	Columns
Batch/gravity flow applications	Yes	Yes	Yes	No
FPLC applications	No	Yes	Yes	No
Scale	Analytical, preparative, production	Analytical, preparative, production	Preparative, production	Analytical
Capacity (mg protein/ml adsorbent)	5–10	5–8	5–10	2–4
Matrix	Sepharose 6B-CL (6% cross-linked agarose)	Superflow (6% cross-linked agarose)	Uniflow (4% cross-linked agarose)	Silica
Bead size (µm)	45–165	60–160	300–500	16–24
Maximum linear flow rate (cm/hr)*	30	3,000	800	n/a
Maximum volumetric flow rate (ml/min)*	0.5	50	13	n/a
Recommended volumetric flow rate (ml/min)	0.3	1.0–5.0	1.0–5.0	0.3
Maximum pressure	2.8 psi 0.2 bar 0.02 MPa	150 psi 10 bar 0.97 MPa	9 psi 0.62 bar 0.02 MPa	n/a
pH stability (duration)	2–14 (2 hr) 3–14 (24 hr)	2–14 (2 hr) 3–14 (24 hr)	2–14 (2 hr) 3–14 (24 hr)	2–8.5 (2 hr) 2–7.5 (24 hr)
Protein exclusion limit (Da)	4×10^7	4×10^6	2×10^7	n/a

*For washing and elution only.

Protein Purification Procedures

Batch

In batch purification, the sample is applied to a tube containing resin. After incubation, the tube is centrifuged and the supernatant is discarded. The resin is washed with buffer and centrifuged. Then, elution buffer is added and the supernatant is collected after centrifugation.

Batch/gravity flow

Batch/gravity-flow purification means the protein is bound to the resin in solution and then the protein-resin mixture is applied to a column for washing and elution. This procedure gives efficient binding of 6xHis-tagged proteins, most notably when the 6xHis tag is not completely accessible or when the desired protein in the lysate is present in low concentration. By taking this approach, you optimize the time of contact between the resin and your sample. This method is also simpler and requires less equipment than other methods. Batch/gravity flow is usually intended for small-scale purification.

Standard column chromatography

In column purification, the protein binds the resin directly in the column, not in solution as with batch and gravity-flow purification. The resin is first packed into the column and equilibrated with lysis buffer. Then, the cell lysate is applied to the column. Washing and elution steps follow just as in the batch purification procedure. This method affords higher purity of the final product and is also faster than other methods.

FPLC (Fast Protein Liquid Chromatography)

FPLC is a protein purification technique utilizing inert materials, such as glass or plastic, to purify proteins without any metal leaching from the instruments into the protein sample. This method permits you to run chromatography purification at flow rates of 10 ml/min/cm^2 under medium pressure (up to 3 MPA). High flow rates are desirable because you obtain purified protein much more quickly. Fast purification limits the amount of time your protein spends in the presence of proteases (and other impurities) so you get a higher yield of purified product. However, in order to use such high flow rates, the resin must be able to withstand the associated pressure and maintain permeability. TALON Superflow Resin contains specially cross-linked agarose beads that are stronger than conventional agarose beads, so they can be used in FPLC applications. In addition, TALON Superflow beads have high permeability which results in decreased back pressure at elevated flowrates.

Spin column

Spin-column purification is intended for very small-scale, analytical-grade protein purification. This method is employed when purifying only small amounts of protein from many different samples.

Purification using FPLC

TALON™ Resin is available in the TALON™ Superflow format, which is useful for a variety of applications, including medium-pressure applications with FPLC systems at back pressures of up 150 psi (1 MPa). TALON Superflow can be used at high linear flow rates—up to 5 ml/min/cm^2. This resin is recommended if short purification times are essential, or if purification protocols developed for small or medium scale volumes scale need to be scaled up for larger volumes.

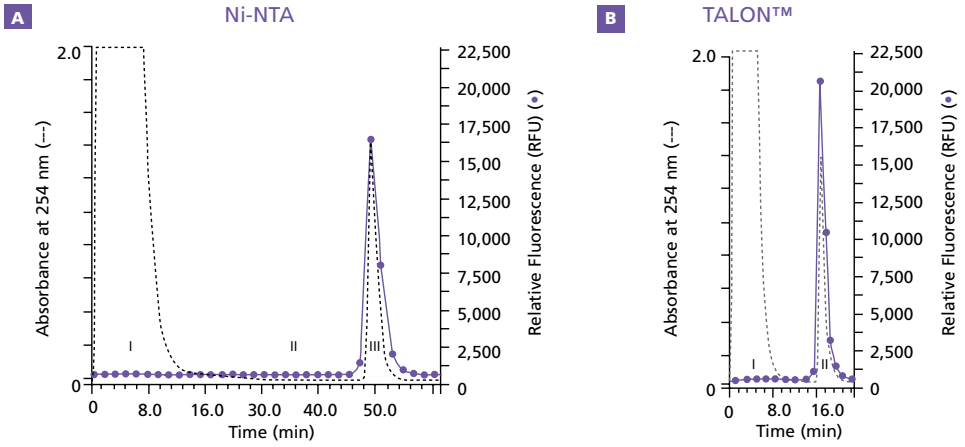

Figure 12. FPLC purification of 6xHis-GFPuv with TALON™ Superflow. Nickel-NTA (**Panel A**) requires longer washing and lower flow rates to purify 6xHis-GFPuv than TALON Superflow (**Panel B**). Protein was extracted in 50 mM sodium phosphate, 0.3 M NaCl, pH 7.0. **Panel A.** 3.2 ml culture filtrate was loaded at 0.5 ml/min. Then nonadsorbed material was washed in the same buffer with 10 mM imidazole. Protein was eluted with 20 mM imidazole (peak II) and 250 mM imidazole (peak III). **Panel B.** 3.2 ml culture filtrate was loaded at 1 ml/min. Then, nonadsorbed material was washed with the same extraction buffer and eluted with 150 mM imidazole (peak II).

Purification using FPLC*...cont.*

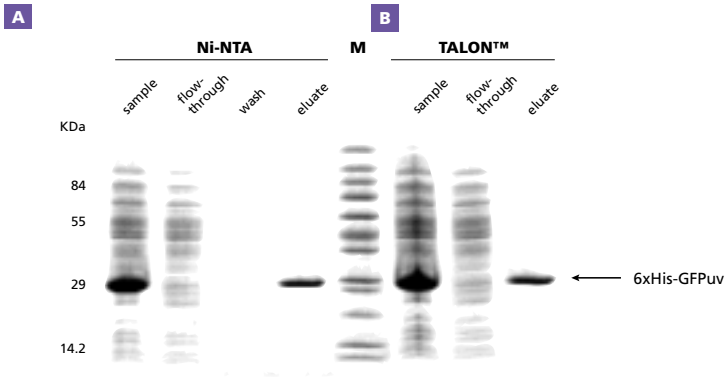

Figure 13. SDS-PAGE of FPLC fractions from 6xHis-GFPuv purification. FPLC purification fractions from the peaks in Figure 11. Purification with TALON Superflow requires less washing with exceptional results.

Table III: TALON™-compatible reagents

Reagent	Acceptable concentration
β-Mercaptoethanol	10 mM (with caution)
CHAPS	1% (with caution)
Ethanol	30% (only for storage)
HEPES	50 mM
Glycerol	20%
Guanidinium-HCl	6 M
Imidazole	200 mM at pH 7.0–8.0 for elution
KCl	500 mM
MOPS	50 mM
NaCl	1.0 M
NP-40	1%
SDS	1% (with caution)
Tris	50 mM
Urea	8 M

Incompatible reagents

- DTT (dithiothreitol)
- DTE (dithioerythritol)
- EDTA (ethylenediaminetetraacetic acid)
- EGTA (ethylene glycol-bis [β-amino-ethyl ether])

Purification from Crude Cell Lysates

TALON CellThru is a novel IMAC resin for purifying polyhistidine-tagged proteins from crude cell lysates, sonicates, and fermentation liquids. The large bead size of TALON CellThru (300–500 µm) permits cellular debris to flow through the column, eliminating the need for high-speed centrifugation. Additionally, destabilizing factors are removed more quickly with TALON CellThru than with other resins, because the number of steps is reduced.

Advantages of direct capture

Traditionally, obtaining protein from crude cell lysates, such as cell culture and fermentation harvests, requires two steps: isolation, followed by column or batch purification. In the isolation step, the removal of particulate material by centrifugation and/or microfiltration is followed by an initial volume reduction step (typically ultrafiltration). Since conventional chromatography columns are quickly clogged by particles such as cells, cell debris, precipitated proteins, the lysate must be particle-free prior to purification. Therefore, the load must be cleaned before applying it to the column.

However, these centrifugation and filtration steps can be time-consuming and expensive and can also compromise quality. Proteases and glycosidases released from the lysed cells can degrade the target protein, complicate purification, and increase purification costs. The longer the target protein is in the presence of the cell lysate, the more likely it is to be degraded.

One alternative to centrifugation and filtration before loading is a technique called **direct capture**. With direct capture, you can minimize protein degradation, improve product quality and yield, and save time and money. Also, the initial recovery procedure can be simplified if protein capture and debris removal are combined into a single operation. TALON CellThru allows you to purify His-tagged protein directly from crude cell lysates, including serum, tissue extracts, cell culture harvests, fermentation broth and other crude samples on resin-packed, standard low-pressure columns.

A large agarose bead adsorbent is packed into standard chromatography columns whose end-plate frits (filters) have large pores (190 µm) to prevent column blockage. Because of the large bead sizes, particulate material flows between the beads while the soluble product binds to the immobilized metal ions on TALON Resin. Residual particulate material can be removed from the column by using bidirectional high-speed wash pulses. The product is the eluted by normal elution methods.

Expanded bed chromatography vs. top-loading

TALON CellThru can be used in expanded bed chromatography. With this type of chromatography, the crude lysate is applied to the column in an upward rather than downward direction, resulting in increased distance between resin particles (Anspach, *et al.*, 1999). Using the upward flow, the bed does not become clogged and a greater amount of protein is recovered.

Expanded bed chromatography integrates solid-liquid separation, volume reduction, and partial purification all into one step. The amount of cellular debris can be reduced up to five orders of magnitude. The combination of increased distance between particles and the large bead size of TALON CellThru allows for excellent protein adsorption without clogging the bed.

Purify Protein from Crude Cell Lysates*...cont.*

The yield from a particular expanded bed or CellThru application depends to a large extent on the efficiency of the extraction procedure in promoting interaction of the target proteins with the resin beads. Incomplete lysis will result in perceived losses of the target protein in the cell debris, which is removed by centrifugation.

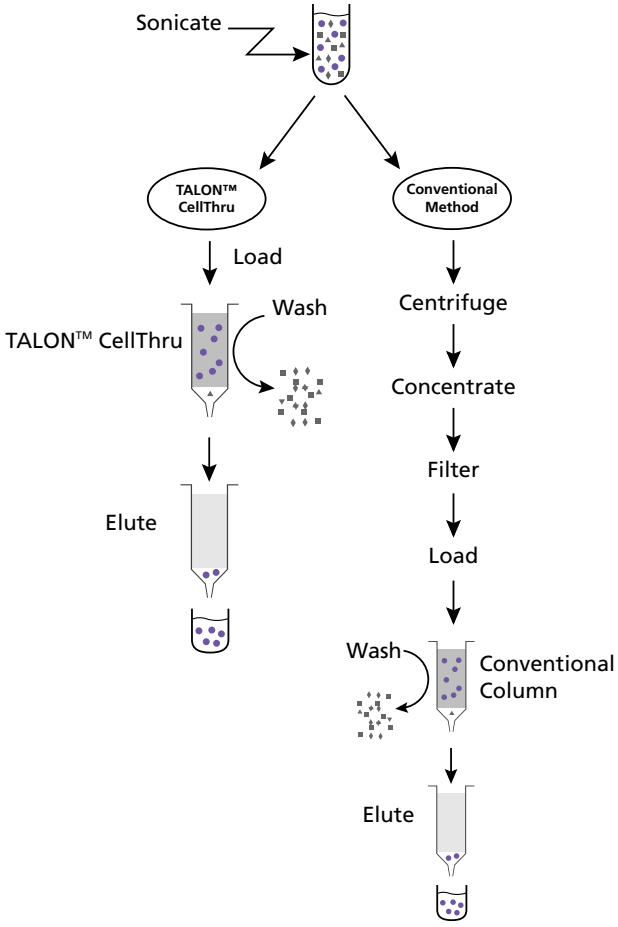

Figure 14. TALON™ CellThru purifies protein from crude cell lysate faster than conventional methods.

CellThru purifies membrane bound proteins and multiprotein complexes

Some proteins are not as easy to access as soluble cytosolic proteins. For example, some recombinant proteins may interact with proteins embedded in the cell membrane (membrane-bound or membrane-associated), while others may be compartmentalized within subcellular organelles. When performing SDS-PAGE analysis, this is generally not apparent because the high SDS and salt concentrations in the sample buffer help solubilize the membranes. Thus, nearly all the proteins present in a cell lysate can be visualized when run on an SDS-PAGE gel.

Purifying membrane-associated proteins with standard TALON Resin is challenging because lysates must be clarified before application to the column. This centrifugation step will usually remove most of the membrane-associated proteins along with the cell membranes and subcellular organelles.

In contrast, with TALON CellThru Resin you can run the crude lysate on the column without centrifuging (direct capture). In this procedure all membranes and unbroken subcellular compartments pass through the column increasing the likelihood of capturing membrane-associated proteins. Therefore, when purifying multiprotein complexes or membrane-associated proteins, TALON CellThru Resin will provide better yields than conventional TALON. However, if a recombinant protein strongly interacts with the membrane or is contained within unbroken subcellular compartments, some proportion of the protein will not be adsorbed by TALON CellThru and will pass through in the wash fractions.

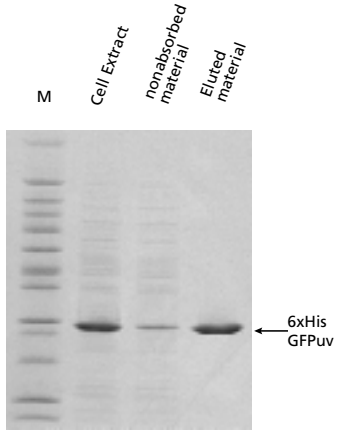

Figure 15. SDS-PAGE of TALON™ CellThru™ purified proteins. *E. coli* BL21 cells were sonicated in TALON wash buffer and run through a TALON CellThru column eluted in 150 mM imidazole. Note that some target protein is trapped in membrane fractions and does not get absorbed on the column. M=molecular weight standards.

TALON Product List	Size	Cat. #
TALON Metal Affinity Resin	10 ml	8901-1
	25 ml	8901-2
	100 ml	8901-3
	250 ml	8901-4
TALONspin Columns	10 cols.	8902-1
	25 cols.	8902-2
	50 cols.	8902-3
	100 cols.	8902-4
TALON 2-ml Disposable Gravity Column		
	50 cols.	8903-1
TALON Superflow Metal Affinity Resin		
	25 ml	8908-1
	100 ml	8908-2
TALON CellThru	10 ml	8910-1
	100 ml	8910-2
CellThru 2-ml Disposable Columns		
	50 columns	8914-1
CellThru 10-ml Disposable Columns		
	20 columns	8915-1
TALON Buffer Kit	each	K1252-1
TALON Purification Kit	each	K1253-1
Talon-Dextran Trial Size	5 mg	8918-y

Thiophilic Resin Product List

Thiophilic-Uniflow Resin	10 ml	8913-1
	100 ml	8913-2
Thiophilic-Superflow Resin	10 ml	8917-1
	100 ml	8917-2

Glutathione Resin Product List

Glutathione-Superflow Resin	10 ml	8911-1
	100 ml	8911-2
Glutathione-Uniflow Resin	10 ml	8912-1
	100 ml	8912-2
GST Purification Kit	5 purifications	K1251-1